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(54) Apparatus and Method in a Paper Machine Twin-Wire
Cylinder Drier Section

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90°C 180°C

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BACKGROUND OF THE INVENTION

This invention relates generally to methods and apparatus in paper making machines and, more particularly, to methods and apparatus in twin-wire cylinder drier sections of paper machines.

Conventional cylinder driers include a line of upper heated drying cylinders and a line of lower heated drying cylinders. Such cylinder drier sections can generally be divided into two groups, namely, single-wire draw cylinder driers and twin-wire draw cylinder driers. In single-wire draw cylinder driers, the web is passed over the heated drying cylinders running from one line of cylinders to the other while supported by a drying wire so that on one line of cylinders, the web is situated between the drying wire and the cylinder surface, while on the other line of cylinders, the web is situated outside of the drying wire with the latter being situated between the cylinder surface and the web. Single-wire draw cylinder driers are advantageous in that the web is supported at all times by the drying wire and has no open draws of any substantial length, whereby the possibilities of web breakage and wrinkle formation are substantially reduced.

In twin-wire draw cylinder driers, separate upper and lower wires are used in connection with the upper and lower cylinders respectively. The wires are guided by the surfaces of the respective drying cylinders and by guide rolls situated in spaces between adjacent drying cylinders. In this manner, the web is pressed by the upper wire in direct drying contact against the surfaces of the upper cylinders, and, correspondingly, is pressed by the lower wire directly against the surfaces of the lower drying cylinders. The web passes between the lines of upper and lower cylinders as an open draw.

The present invention is directed to improvements in methods and

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apparatus in twin-wire draw cylinder drier sections.

In twin-wire draw cylinder drier sections, the web usually has a substantially long open draw as it passes from one line of cylinders to the other. These open draws have been susceptible to fluttering often resulting in breakage and formation of wrinkles in the web. These drawbacks have been particularly acute in the initial part of the drier section where the web is still relatively moist and, therefore, of low strength and its elastic properties are such as to render the web susceptible to fluttering.

Attempts have been made in the past to eliminate these drawbacks by reducing the length of the open draws of the web in the initial part of the drying section by moving the cylinders of the upper and lower lines closer to each other, i.e., by situating the imaginary planes containing the axes of the upper and lower lines of the cylinders at a shorter distance from each other. However, this tends to reduce the drying efficiency of the arrangement.

It has also been suggested to convert the third and fourth groups of drying cylinders in the drier section to single-wire draw arrangements. However, this is considered to be an extreme solution since it results in reduced efficiency of evaporation and increased difficulty in air-conditioning.

Attempts have also been made to reduce fluttering of the paper web in twin-wire draw cylinder driers by displacing the felt or wire guide rolls in a manner such that the unsupported run of the web is reduced in length. U.S. patent 3,753,298 discloses such an arrangement. Moreover, a Swedish paper machine in which the guide rolls are positioned in accordance with U.S. patent 3,753,298 is described in the paper "Engineering Consideration for Lightweight Paper Drying in High Speed Machines", Paper Technology In Industry, July/August 1978. This machine has reached a running speed of 850

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m/min. However, fluttering of the web has continued to be a difficulty.

The fluttering of a paper web has also been considered in the paper "Paperin valmistus" (Manufacture of paper) (Suomen Paperi-insinöörien yhdistyksen oppi - ja käsikirja III osa) - Textbook and Manual of the Association of Paper Engineers in Finland, Vol. III, Part 1) on pages 699 to 700. This article suggests that fluttering of the edge of a web is generally not caused by air flow which had been frequently assumed. Under such circumstances, the fluttering of a web could not be prevented to a significant extent by guiding the air flows in the drying section, which has, however, often been attempted.

Web fluttering is today considered to result essentially from excessively strong airflows in the pockets defined inside the cylinder drier by the free surfaces of the drying cylinders and the wires or felts guided by the guide rolls, and from differences in pressure prevailing both in the pockets and in the nips formed by the web and the wire and by the cylinder surfaces. The strong airflows and the differences in pressure that are produced are results of boundary-layer flows which are induced by the wires, by the web, and by the cylinder surfaces, as they move.

The pockets defined by adjacent open draws of the web, the free surfaces of the corresponding drying cylinders, and the wires or felts guided by the guide rolls, are open at their ends but are otherwise closed. The ventilation or air-conditioning of such pockets has been considered an important factor with respect to the efficiency and uniformity of the drying accomplished in the multi-cylinder drier section.

In recent years, the running speed of paper machines has been constantly increased and is now approaching 1500 m/min. As the

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running speeds of paper machines increase, the fluttering of the open draws of the web becomes a more serious problem hampering the running quality of the paper machine. Transferring the web from the press section to the drier section and the support of the web within the area of a single-wire draw drier section can be controlled by means of arrangements suggested in earlier patents and patent applications of applicants' assignee. However, in the case of the twin-wire draw cylinder drying groups and, particularly, in the case of the third and fourth drying groups, difficulties often occur at high running speeds. The prior art arrangements are not directed to arrangements which affect the quantities of air pumped into the pockets of the drier section so that the web should be suctioned into contact with the drying wire as it separates from a drying cylinder to enter into a pocket.

In prior art twin-wire draw cylinder driers, the quantity of air pumped into the pocket depends mainly on the speed of the machine, on the geometry of the drier section, and on the permeability of the drying wire.

The regulation of the moisture profile in the pockets is accomplished in the prior art by arranging blow pipes in the pockets which are divided into blocks in the transverse direction, the blocks being separately openable and closeable so as to regulate the quantity of air directed into the pocket. In this connection, reference is made to Finnish Patent 68,278 assigned to applicants' assignee.

It is known that in a twin-wire draw cylinder drier, a moist boundary layer is produced on the drying wire as it runs on a cylinder as water vapor is evaporated from the web and diffused through the wire. When the wire separates from the cylinder, this moist boundary layer passes through the wire into the pocket due to

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the negative pressure present in the nip. It has not been possible to eliminate the boundary layer by means of prior art pocket ventilation devices. It is an object of the present invention to provide a solution for this problem.

5 An arrangement by which web fluttering within the open draws of the web can be substantially reduced to thereby lower the risks of web breakage, web wrinkling and extension of the web, is an object of the arrangement disclosed in US patent 4,694,587. Another object of this US patent is to
10 provide an arrangement for ventilating the pockets and for controlling the transverse moisture profile of the web. It is therein suggested that as the web and the drying wire separate from the drying cylinder, the web is subjected to a suction effect through the drying wire by providing an area
15 of negative pressure at that portion of the drying wire run. The web therefore adheres to the drying wire, thereby substantially reducing the length of the open draw of the web. Suction effect is produced by directing gas or air jets in the direction opposite to the direction of travel of the
20 adjoining drying wire run and of the adjoining wire guide roll. The air jets act to eject air out of the spaces behind them to produce the areas of negative pressure.

 On the other hand, in the apparatus disclosed in the above-mentioned US patent, it was considered novel that the
25 device comprises a blow box which extends over substantially the entire width of the drying wire, that the blow box is

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provided with at least two nozzle slots which are placed and constructed so that separate gas or air jets are directed by them in a direction opposite to the direction of movement of the drying wire situated opposite to the first nozzle slot
5 and in a direction opposite to the direction of movement of the free surface of the wire guide roll situated in opposed relationship to the second nozzle slot.

Since in the arrangement of the US patent, the web does not run in a straight path onto the next drying cylinder,
10 but, rather, follows along with the drying wire up to the guide roll substantially to its horizontal center plane, the free unsupported draw of the web can be considerably shortened and thereby stabilized. Moreover, such an unstable web run in the outlet nip can be eliminated in which case an
15 uncontrolled negative pressure at both sides of the web will exist. A negative pressure at both sides of the web has resulted in fluttering in prior art arrangements. The quantity of air pumped into the pocket can be adjusted by the apparatus disclosed in US patent 4,694,587 by regulating the
20 negative pressure produced by means of the gas jets. In its simplest form, negative pressure is regulated by adjusting the pressure in the blow box. Negative pressure can be regulated independently of the permeability of the drying wire.

25 The arrangement disclosed in US patent 4,694,587 also effects both the quantity of air removed from the pocket as

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well as the transverse distribution of the air quantity, the latter effecting the moisture profile of the web. This takes place so that the gas jet or jets are directed on the run of the drying wire on which the wire returns from the guide roll to the drying cylinder onto the web, in a direction opposite to the direction in which the wire runs, preferably by means of the same blow box which acts to produce the areas of negative pressure. These gas jets produce a positive pressure which reduces the air flow pumped out of the pocket through the wire. The regulation of the moisture profile of the web is performed by means of this arrangement at the outlet side of the drying wire so that when a blow block is open, it results in a moistening effect on the web since air is not pumped out of the pocket. When the blow block is closed, a drying effect is produced on the run of the web that faces the block since air can be pumped from this portion of the pocket. Under the circumstances, the control of the moisture profile of the web takes place exactly in the opposite way as compared with prior art pocket ventilation methods.

Another advantage of the arrangement disclosed in US patent 4,694,587 is that the arrangement permits the use of very open drying wires, i.e., of wires of high permeability, so that it is possible to use open drying wires having a permeability such as within the range of 10,000 to 15,000 $\text{m}^3/\text{m}^2 \times \text{h}$, whereas the permeability of wires commonly used in

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prior art twin-wire drier sections is generally within the range of between about 1,500 to 2,000 $\text{m}^3/\text{m}^2 \times \text{h}$. Since the drying wires are substantially more open than those used in conventional prior art arrangements, the evaporation that takes place on the cylinders through the wires increases again resulting in a reduction in the average moisture level in the pockets. The ventilation that takes place through the outlet nips between the cylinder and the drying wire is also increased due to the more open wires.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide new and improved apparatus and methods in twin-wire draw cylinder driers of paper machines.

Another object of the present invention is a further development of the arrangement described in US patent 4,694,587 which retains the advantages provided by the disclosed arrangement so that the air-conditioning of the web can be intensified and the running quality of the paper machine improved in the area of the twin-wire draw. Since attempts are always being made to increase the running speeds of paper machines, higher requirements are satisfied in accordance with the invention.

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A further object of the present invention is to provide new and improved methods and apparatus in twin-wire cylinder driers wherein the negative pressure produced at the inlet side of the wire run from the cylinder to the guide roll can be significantly increased relative prior art arrangements, whereby the draw of the web is improved significantly.

An arrangement in accordance with the invention, may, if desired, be applied to a pocket ventilation arrangement provided at the outlet side of the wire run between the guide roll and the drying cylinder. The pocket ventilation arrangement can advantageously be provided in blocks in the transverse direction of the paper machine so as to control the moisture profile and prevent excessive drying of the lateral areas of the web.

Briefly, in accordance with the present invention, these and other objects are obtained by providing a method wherein an oblong passage is provided in the negative pressure zone produced by the gas jet and by directing the gas jet through the oblong passage. The oblong passage is defined by the outer surface of the wire which is situated on the drying cylinder and by the surface of the wall of a blow box. By means of the oblong passage, the boundary-layer flow following along with the drying wire is substantially reversed so as to become a flow in a direction opposite to the run of the wire. An adequate level of negative pressure is also isolated in the space situated at the rear side of the passage.

In accordance with the apparatus of the invention, after the nozzle, which preferably comprises a Coanda nozzle, in the direction of the gas jet, a wall of the blow box is arranged so that together with the outer surface of the wire situated on the surface of the drying cylinder facing that wall, an oblong passage is defined, the

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length of which is several times larger than its width.

The width of the passage is the distance between the outer surface of the wire and the surface of the blow box wall.

According to the invention, a relatively long counterflow blow passage is employed on the rung of the lower and upper wires between the drying cylinder and the wire guide roll outside of the wire loop. The length of the counterflow blow passage is chosen so that the boundary-layer flow following the wire on its outer surface can be substantially completely reversed by means of the counterflow in the passage so as to flow in the opposite direction thereby effectively preventing any pumping action by the wire towards the nip formed between the wire and the wire guide roll.

In accordance with the invention, the length of the counterflow blow passage is generally within a range of between about 100 to 500 mm, and preferably within a range of between about 250 to 350 mm. The width of the passage, i.e., the distance between the blow box wall that defines the passage and the wire situated on the surface of the drying cylinder is generally within a range of between about 20 to 100 mm and preferably within a range of between about 40 to 70 mm. The width of the counterflow passage can be chosen with a view towards facilitating the installation of the blow box since the width is sufficient to assure secure operation.

By means of the invention, an increased negative pressure is provided at the inlet side of the wire in the nip formed between the wire and the guide roll. In particular, the negative pressure level can be as high as about -100 Pa.

In a preferred embodiment of the invention, the negative pressure is provided in the inlet nips between the wires and their respective guide rolls by using only a single nozzle and a sealing arrangement in which case the amount of air or gas required to

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provide the air or gas jets can be significantly reduced.

Generally, a distance of at least about 50 mm is required between the blow box and the surface of the moving wire for reasons of security. This distance can be provided without any difficulty in accordance with the invention. Nevertheless, the invention will provide an increased level of negative pressure in the inlet nip between the wire and its guide roll.

DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the present invention and many of the attendant advantages thereof will be readily understood by reference to the following detailed description when considered in connection with the accompanying drawings, it being understood that the invention is in no way limited to the particular embodiments shown in the drawings, and wherein:

Fig. 1 is a schematic side elevation view of a twin-wire cylinder drier in accordance with the invention;

Fig. 2 is a schematic plan view of a blow box used in the arrangement of Fig. 1 viewed in the direction of arrow D of Fig. 1;

Fig. 3 is an enlarged schematic side elevation view of a first embodiment of the invention wherein two blow nozzles and pocket ventilation are provided;

Fig. 4 is a view similar to Fig. 3 illustrating another embodiment of the invention wherein only a single blow nozzle is employed and wherein a sealing arrangement is provided as well as a pocket ventilation nozzle arrangement;

Fig. 5 is a view similar to Figs. 3 and 4 illustrating an embodiment of the invention in which two blow nozzles are provided without provisions for pocket ventilation; and

Fig. 6 is a view similar to Figs. 3-5 of an embodiment of the

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invention wherein only a single blow nozzle is employed without provisions for pocket ventilation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein like reference characters designate identical or corresponding parts throughout the several views, and more particularly to Fig. 1, a twin-wire draw multi-cylinder drier in accordance with the invention includes a line of lower drying cylinders 31, 32, ... and a corresponding line of upper drying cylinders 41, 42, A lower wire 30 is guided by guide rolls 34, 35, ... situated between adjacent pairs of lower cylinders 31, 32, Correspondingly, an upper wire 40 is guided by guide rolls 44, The paper web W is situated under the drying wires 30, 40 in direct contact with the surfaces of both the lower and upper drying cylinders. The web W has open draws W_p as it travels between the lines of cylinders and it is these open draws which, as a rule, have been susceptible to fluttering in conventional drier sections of this type. On the other hand, evaporation of water from the web W takes place to a remarkable extent on these open draws W_p . The frame construction of the drier section is conventional and is omitted from the drawings for purposes of clarity.

As seen in Figs. 1-6, a blow box in accordance with the invention is provided in each of one or more of the spaces between the lower and upper cylinders, the blow boxes extending in the transverse direction over the entire width of the web W and drying wires 30 and 40. A blow box 10 includes substantially vertical walls 14 and 16 and substantially horizontal walls 15 and 17, the wall 15 being situated in opposed relationship to the free sector of a respective one of guide rolls 34, 35 and 44, spaced a small distance therefrom to form a small gap V. The walls 14 and 15 are reinforced

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by means of tubular members 11a and 12a which extend over the entire width of the blow box 10. As shown in Figs. 3 and 5, Coanda nozzle slots 11 and 12 are provided in connection with the tubular members 11a and 12a, the nozzle slots 11 and 12 being in part defined by the tubular members 11a and 12a in combination with sheet members or edge folds of the walls 14 and 15. The transverse ends of blow box 10 are closed by walls 21 (Fig. 2). Air ducts 22 are provided in one or both of the walls 21 through which pressurized blow air and pocket ventilation air, if any, are introduced into the box 10. The pressure p of the blow air is preferably in the range of between about 1000 to 1500 Pa.

The Coanda nozzle 11 of each blow box 10 is situated proximate to a respective drying wire 30, 40 in the region where that drying wire separates from a respective drying cylinder 31, 41 and is constructed to direct a gas jet F_1 (which generally comprises an air jet) along the drying wire 30, 40 in a direction opposite to the direction of travel of the drying wire. The other nozzle slot 12 is situated proximate to the respective one of guide rolls 34, 44 and is constructed to direct an air jet F_2 along the guide roll 34, 44 in a direction opposite to the direction of movement of the roll surface.

In accordance with the invention, the gas jet or jets F_1 directed through the first Coanda nozzle 11 is blown in a direction opposite to the direction of movement of the drying wire 30, 40 through an oblong passage R. The length L of passage R is generally within the range of between about 100 to 500 mm, and preferably within the range of between about 250 to 350 mm. The width W of the passage, comprising the distance between the curved vertical wall 14 of blow box 10 and the drying wire 30, 40 in opposed relationship thereto is generally within the range of between about 20 to 100 mm,

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and preferably within the range of between about 40 to 70 mm, such as about 50 mm, which is usually the distance from the drying wire required for safety. Generally, the ratio of the length L of passage R to the width M of passage R , i.e. L/M , is generally within the range of between about 3 to 10, and preferably within the range of between about 5 to 7. Such dimensions insure, firstly, that air is efficiently ejected from the negative pressure spaces A^- and B^- , and secondly, that the boundary layer flow that follows the outer surface of the wires 30, 40 is substantially completely eliminated and reversed to a direction parallel but opposite to the direction of movement of the drying wire.

By means of air jets F_1 and F_2 , air is ejected from the space A^- between the drying wire 30 and the wall 14 of blow box 10 as well as from the wedge space B^- between the drying wire 30, 40 and the guide roll 34, 44 in the directions of arrows B_1 and F_2 so that a negative pressure is efficiently produced in the spaces. The negative pressure produced by the air jets, which may reach a level on the order of about -100 Pa causes the web W to efficiently adhere to the drying wire 30, 40 after the web has been detached from the surface 11, 41 of the drying cylinder since the drying wires 30, 40 are relatively air permeable. The web W remains in contact with the surface of wire 30, 40 until the end of nip N , i.e. up to a line where the drying wire 30, 40 contacts the guide roll 34, 44. This point of contact is situated in a horizontal plane containing the center point of the guide roll 30, 40 or a plane proximate thereto. The web detaches from the drying wire 30, 40 after this point and continues towards the next drying cylinder having a substantially shorter free run W_p .

The width of the nozzle slots 11 and 12 is generally in the range of between about 2 to 5 mm. The speed of the air jets F_1 and

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F_2 through nozzle slots 11 and 12 is generally in the range of between about 15 to 50 m/s.

The particular features of the various embodiments illustrated in Figs. 3-6 and the differences between these embodiments will now be described. Referring to the embodiment shown in Figs. 3 and 4, the blow box includes an arrangement for ventilating or conditioning the air in the pockets defined between the adjacent free runs W_p of web W , the free sector of drying cylinder 32 and the drying wire 40 guided by guide roll 44. Ventilation of this pocket is provided by producing a positive pressure area $S+$ on the return run of the drying wire 40 traveling between the guide roll 44 and the drying cylinder 42. The positive pressure area $S+$ provided on the side of the return run of the drying wire results in a flow F_{in} being produced through the wire 40 into the pockets T to ventilate the same. According to the embodiment of Fig. 3, the flows F_2 are arranged in the central region of the web W since the lateral regions of the web have a natural tendency to dry more extensively.

The positive pressure area $S+$ is produced by means of a nozzle 13 provided in the outer wall of blow box 10 connected to an air duct 18. As seen in Figs. 2, 3 and 4, air jets F_1 are directed through the nozzle 13 in a direction opposite to the direction of movement of the wire 30, 40 so that an area $S+$ of positive pressure is produced in the gap space between the straight run of the wire 30, 40 and the wall 16 of blow box 10, as well as in the outlet nip between the wire and the guide roll. The positive pressure is further increased by the air jets F_2 directed through nozzle 12 as is shown in Fig. 3.

In the embodiment of Fig. 4, the second nozzle 12 employed in the embodiment of Fig. 3 is eliminated. In this embodiment, a seal 20 attached to a tubular member 19 is provided which drags against the outer surface of a respective guide roll 34, 35, 44 and seals and

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separates the negative pressure areas A-, N- from the positive pressure area S+. In the embodiment of Fig. 4, an ejection flow E_2 (Fig. 3) is not produced through the gap space V.

Referring to Fig. 2 which illustrates the blow box 10 of Figs. 3 or 4 from the direction B of Fig. 1, blow box 10 comprises a blow nozzle 13 divided into blocks $13_1 \dots 13_N$ for pocket ventilation. Adjustable air flows $F_{31} \dots F_{3N}$ are directed from the blow nozzle blocks $13_1 \dots 13_N$ into the slot space S+. Pressurized air for the air flows is passed into the nozzle blocks $13_1 \dots 13_N$ through the duct 18 which is itself divided into blocks $26_1 \dots 26_N$. The duct blocks $26_1 \dots 26_N$ are provided with adjusting valves $25_1 \dots 25_N$ by means of which the magnitude of the air jets $F_{31} \dots F_{3N}$ directed through the nozzle blocks $13_1 \dots 13_N$ can be adjusted. The inlet flow F_{in1} is passed through a duct 22 into the blocks $26_1 \dots 26_N$ of duct 18. Correspondingly, the air passed through nozzles 11 and 12 (Fig. 3) or through nozzle 11 alone (Fig. 4) is introduced through the opposite duct 23 as inlet flow F_{in2} . The inlet air flow F_{in1} for pocket ventilation comprises hot, dry air. On the other hand, it is possible to use moist air for the gas jets F_1 . The air passed through the second nozzle 12 in the case of the embodiment of Fig. 3 is preferably dry air since it enters into the pocket T for air-conditioning purposes.

As seen in Fig. 1, the wire 40 and free run w_p of the web w arrive at the inlet nip N+ of cylinder 42 separately.

Instead of drying wires which are conventionally used in twin-wire draw cylinder driers, whose permeability is generally within the range of between about 1500 to $2000 \text{ m}^3/\text{m}^2 \times \text{h}$, it is advantageous to use for the drying wires 30, 40, wires which are substantially more permeable. Preferably, the permeability of drying

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wires 30, 40 is within the range of between about 5000 to 20,000 $m^3/m^2 \times h$, and most preferably within the range of between about 10,000 to 15,000 $m^3/m^2 \times h$.

In the illustrations of Figs. 3-6, the respective proportions of the various gap spaces are shown in a substantially accurate manner. The size of the nozzle slots 11-12 has been exaggerated to some extent for purposes of clarity. An example of the dimensions of a twin-wire drier section in accordance with the invention is as follows, it being understood that the invention is not limited to components having these particular dimensions. The diameter of the drying cylinders 31, 32, 41, 42 is 1,030 mm, the distance between planes containing the central axes of the upper and lower lines of drying cylinders is 200 mm, the spacing between the cylinders in the upper line and the lower line in the horizontal direction is 2,600 mm, and the diameter of the guide rolls 14, 35, 44 is 700 mm.

As is well known, the initial cylinder groups in a paper machine drier section usually comprise single-wire draw groups, while twin-wire draw groups are used in the subsequent groups, for example, in the third to fourth groups. The method and apparatus of the invention are applied in one or several groups of twin-wire drier sections, either in one or in several spaces between adjacent cylinders. Advantageously, the invention may be applied for example in one or two of the first groups of twin-wire draw drier sections in the direction of web run where the web is most susceptible to fluttering because of its moisture level and its strength and elasticity properties.

Obviously, numerous modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the claims appended hereto, the invention may be practiced otherwise than as specifically disclosed herein.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. In a twin-wire cylinder drier section of a paper machine including a line of upper drying cylinders, a line of lower drying cylinders, upper guide rolls, each situated between a pair of adjacent upper cylinders, lower guide rolls, each situated between a pair of adjacent lower cylinders, an upper drying wire running over upper surfaces of said upper cylinders guided by said upper guide rolls, and a lower drying wire running over lower surfaces of said lower cylinders guided by said lower guide rolls, spaces being defined between respective pairs of adjacent drying cylinders in said upper and lower lines by respective runs of said upper and lower drying wires between said pairs of adjacent drying cylinders, and by free sectors of respective ones of said upper and lower guide rolls situated between respective pairs of adjacent drying cylinders, and wherein a paper web runs through said drier section contacting said upper and lower surfaces of said upper and lower cylinders between said cylinder surfaces and said upper and lower wires respectively, and has open draws between the lines of cylinders, a blow box situated in one of said spaces, comprising:

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first nozzle means including at least one nozzle slot for directing a gas jet in a direction opposite to the direction of movement of one of said drying wire runs; and

a first wall situated after said nozzle means in the direction of said gas jet in opposed relationship to a run of said drying wire situated over the surface of said drying cylinder traveling towards said guide roll, said wall together with the outer surface of said drying wire defining an oblong passage having a length and a width defined by the distance between the outer surface of the drying wire and the outer surface of said wall, and wherein the length of said oblong passage is several times greater than its width and said oblong passage is substantially of uniform width.

2. The combination of claim 1 wherein said first nozzle means comprises a Coanda nozzle.

3. The combination of claim 1 wherein the length of said oblong passage is in the range of between about 100 to 500 mm and the width of said oblong passage is in the range of between about 20 to 100 mm.

4. The combination of claim 1 wherein the length of said oblong passage is in the range of between about 250 to 350 mm and the width of said oblong passage is in the range of between about 40 to 70 mm.

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5. The combination of claim 1 wherein the ratio of the length of said oblong passage to its width is in the range of between about 3 to 10.

6. The combination of claim 1 wherein the ratio of the length of said oblong passage to its width is in the range of between about 5 to 7.

7. The combination of claim 1 wherein said blow box further includes, a second wall situated in opposed relationship to said free sector of said guide roll defining said space forming a small gap therewith, and

second nozzle means provided at said second wall for directing a gas jet in a direction opposite to the direction of movement of said free sector of said guide roll.

8. The combination of claim 7 wherein said second nozzle means comprises a Coanda nozzle.

9. The combination of claim 1 wherein said blow box further includes sealing means situated proximate to said free sector of said guide roll defining said space for sealing a first negative pressure space defined by an incoming run of said drying wire traveling towards said guide roll from a second positive pressure space defined by an outgoing run of said drying wire traveling away from said guide roll.

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10. The combination of claim 1 wherein said blow box further includes,

an additional wall situated in opposed relationship to and at a small distance from a run of said drying wire, and additional nozzle means provided at an outer part of said additional wall for directing a gas jet into a space between said additional wall and drying wire run to produce a positive pressure in said space.

11. The combination of claim 10 wherein said additional wall is substantially planar.

12. The combination of claim 10 wherein said nozzle means comprise a Coanda nozzle.

13. The combination of claim 10 further including duct means coupled to said additional nozzle means for supplying said additional nozzle means with drying pocket-ventilation air, and said duct means being adjustable in blocks for controlling the transverse moisture

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profile of the web.

14. A method in a twin-wire cylinder drier section of a paper machine including a line of upper drying cylinders, a line of lower drying cylinders, upper guide rolls, each situated between a pair of adjacent upper cylinders, lower guide rolls, each situated between a pair of adjacent lower cylinders, an upper drying wire running over upper surfaces of said upper cylinders guided by said upper guide rolls, and a lower drying wire running over lower surfaces of said lower cylinders guided by said lower guide rolls, spaces being defined between respective pairs of adjacent drying cylinders in said upper and lower lines, respective runs of said upper and lower drying wires between said pairs of adjacent drying cylinders, and by free sectors of respective ones of said upper and lower guide rolls situated between respective pairs of adjacent drying cylinders, and wherein a paper web runs through said dryer section contacting said upper and lower surfaces of said upper and lower cylinders between said surfaces and said upper and lower wires respectively, and has open draws between lines of cylinders, and wherein upon a web and a drying wire departing from a drying cylinder, the web is subjected to a suction effect through the drying wire within a negative pressure zone provided at a portion of the web run in which it contacts the drying wire to reduce the length of the open draw of the web, a suction effect being produced by directing a first gas jet in a direction opposite to the running direction of said drying wire in the region of said negative pressure zone, said first gas jet ejecting air from spaces behind it to produce said negative pressure zone, said method including an improvement comprising the steps of:

said gas jet directing step including directing the first gas jet through a passage which is oblong in the direction of

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the first gas jet, said passage being defined by an outer surface of a run of said drying wire situated over the surface of said drying cylinder and travelling towards said guide roll and by a wall of a blow box situated in said space such that the boundary layer flow following said drying wire run is substantially reversed to a direction opposite to the run of said drying wire whereby a negative pressure is created in areas at a rear side of said passage.

15. The method of claim 14 including the step of selecting the speed of said first gas jet and the dimensions of said passage such that in the spaces defined by said wire after said passage, the web adhering to the opposite side of said wire, said wire guide roll, and said blow box wall, a negative pressure is produced in the range of between about -75 to -150 Pa.

16. The method of claim 15 wherein said negative pressure is about -100 Pa.

17. The method of claim 14 comprising the further step of directing a second gas jet into a gap space between a free sector of said guide roll and a second wall of said blow box to eject air from a nip formed by said drying wire and said guide roll.

18. The method of claim 15 including the step of reducing an area of positive pressure in a region of a run of said drying wire travelling from said guide roll to a drying cylinder by directing an additional gas jet through a gap space defined between an additional wall of said blow box and said drying wire run.

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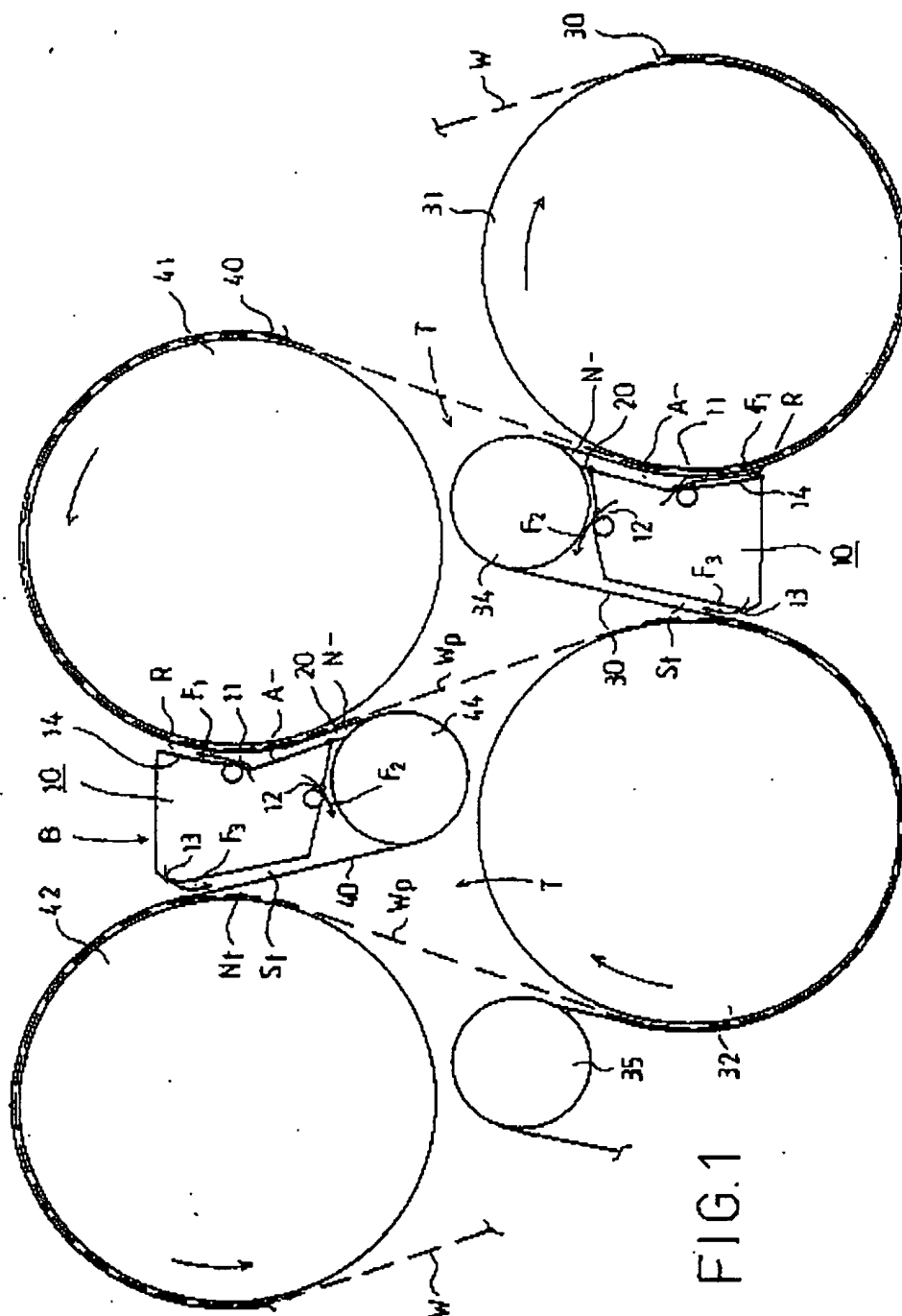


FIG. 1

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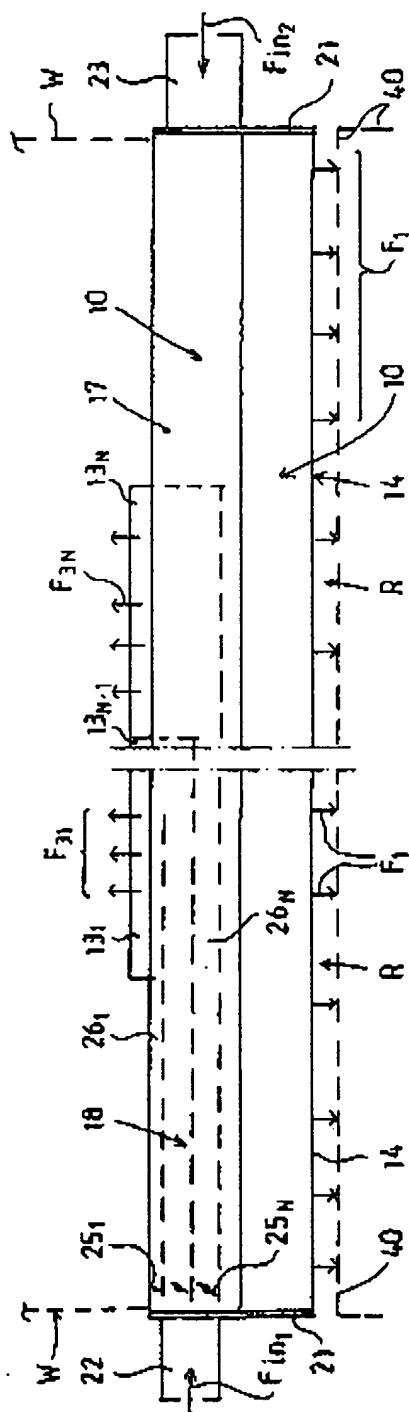


FIG. 2

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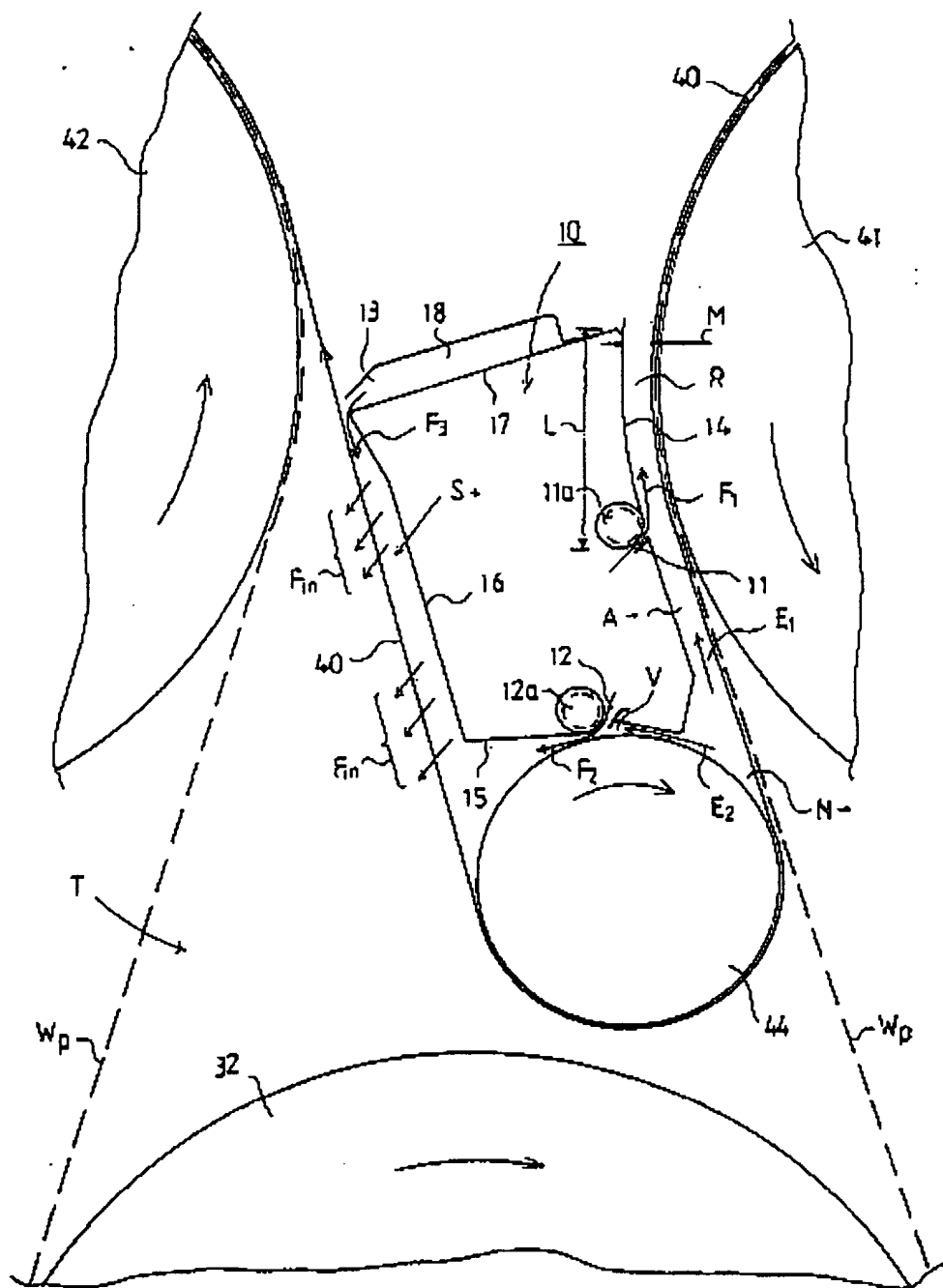


FIG. 3

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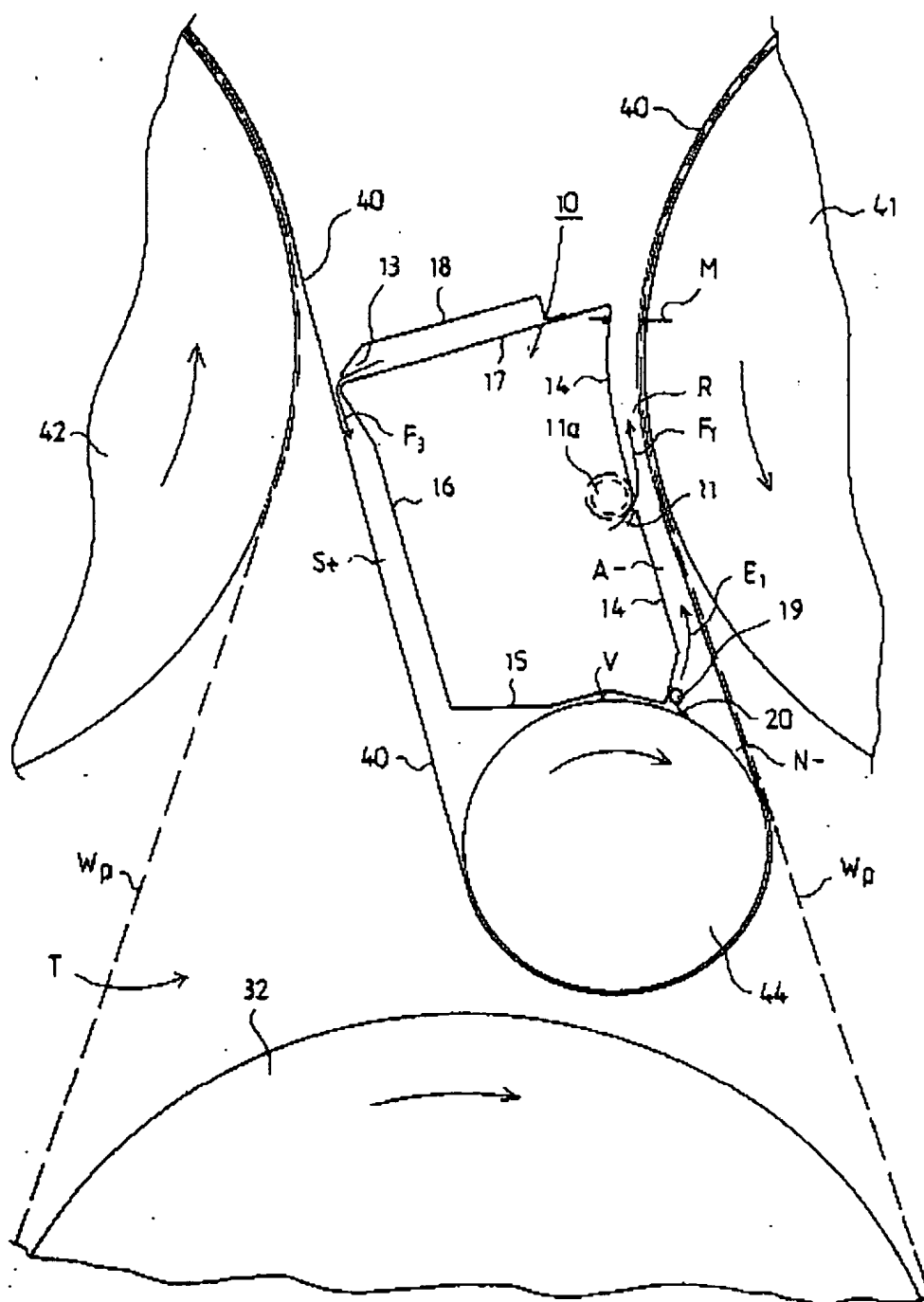
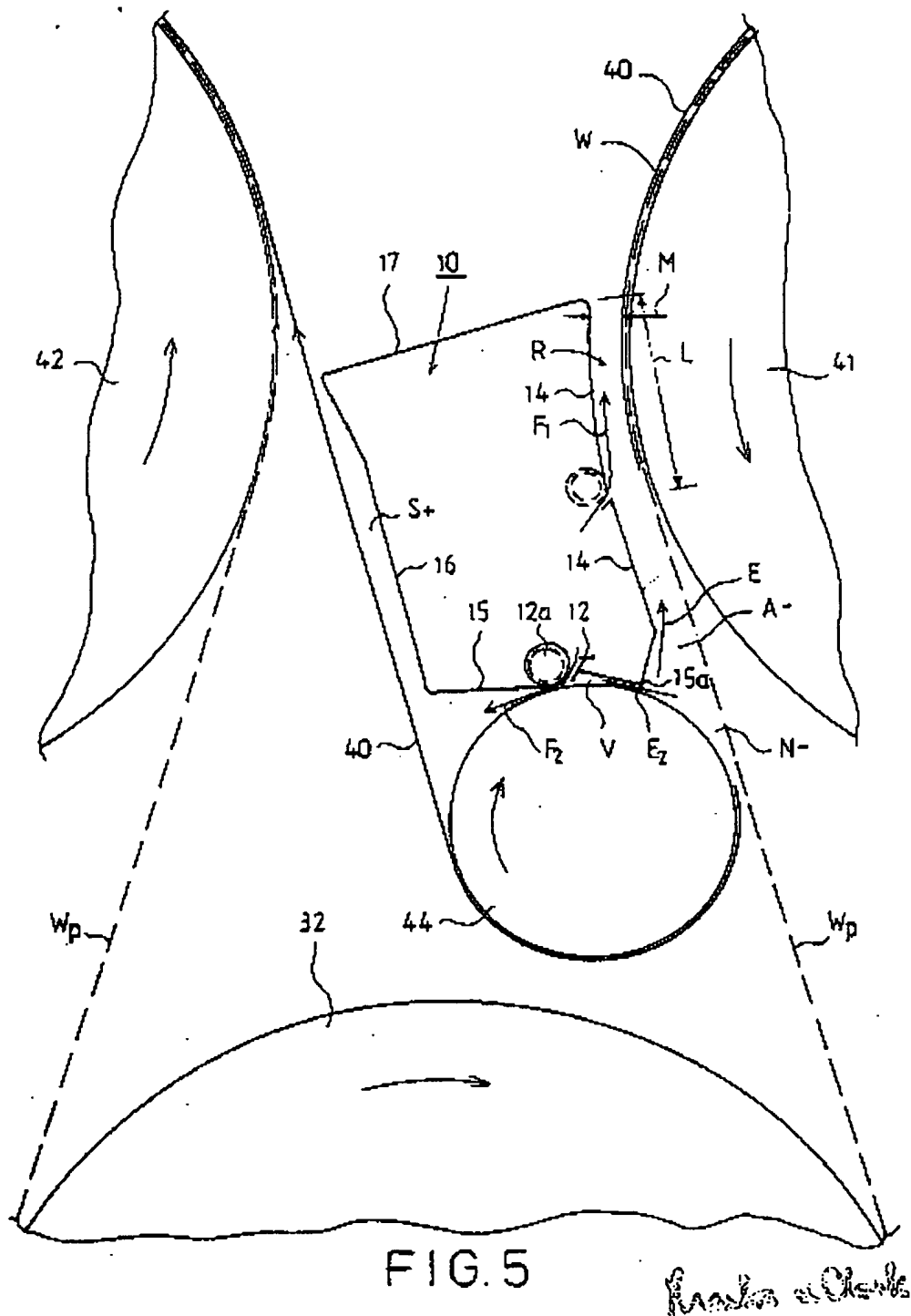


FIG. 4

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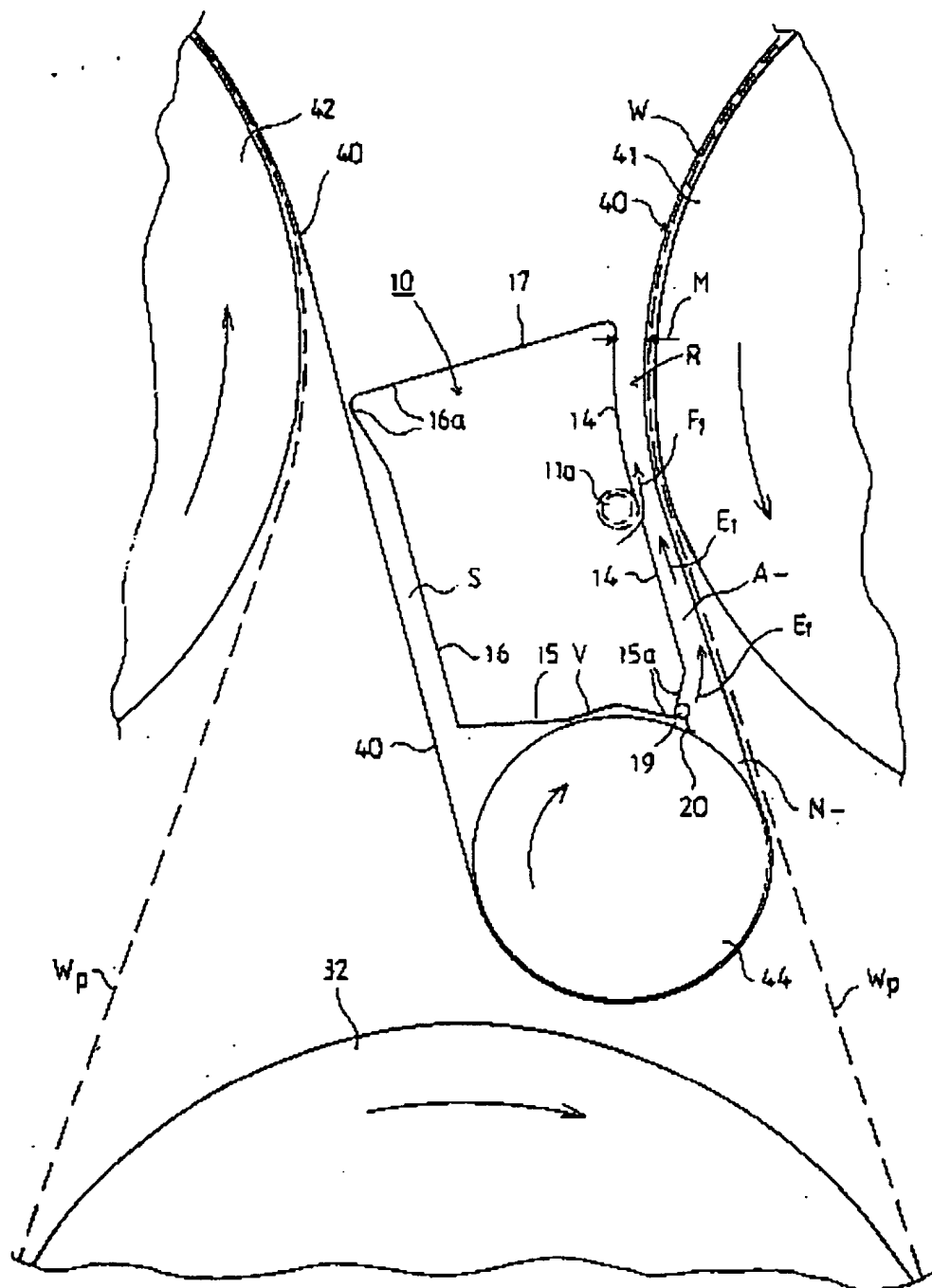


FIG. 6

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ABSTRACT OF THE DISCLOSURE

A web travelling through a twin-wire cylinder drier of a paper machine is subjected to a suction effect as it separates from a drying cylinder within a negative pressure zone provided at a region of its run at which it is in contact with the drying wire so that the length of the open draw of the web is substantially reduced. The negative pressure zone is produced by a gas jet which is directed through an oblong passage defined by the outer surface of the drying wire situated on the drying cylinder and by the surface of a wall of a blow box. By directing the gas jet through the oblong passage, the boundary-layer flow following the drying wire is substantially reversed in direction to flow in a direction opposite to the run of the drying wire to thereby produce a negative pressure space at the rear side of the passage.

